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Development of "*Marine Eco-Adventure*" Educational Game Integrating Larungan Traditions to Enhance Junior High Disaster Preparedness

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Abstract

The strategy to improve student preparedness for disasters is to integrate the basic concepts of disaster in learning with local wisdom related to the sea, such as the use of "Marine Eco-Adventure" marine educational games that integrate the sidiqtraditions of defence with the context of disastrous events. The research aims to discover Marine Eco-Adventure's development, viability, and effectiveness as an educational game that can improve disaster preparedness. The research uses a qualitative approach with a one-group pre-test and post-test design. The sample used is randomly selected. The data was collected through dual selection questions (pre-test and post-test) and analyzed with the t-test. The research showed that the Marine Eco-Adventure developed deserved to be used in learning, with validation results from material and media experts in high categories. Marine Eco-Adventure is effective in improving preparedness for disaster mitigation. The findings suggest that integrating local wisdom with disaster education through interactive games like Marine Eco-Adventure can enhance students' awareness and readiness for disaster events. It highlights the potential for educational games to make learning engaging, culturally relevant, and impactful in real-world contexts. The implications of this research suggest that similar educational tools can be adapted and implemented in other regions to integrate local wisdom with disaster preparedness education, thereby fostering a deeper cultural connection and enhancing overall community resilience.

Keywords: disaster preparedness; educational games; larungan tradition; learning media

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INTRODUCTION

Geographically, Indonesia is an island nation that is at the meeting of three major tectonic plates, namely the Indo-Australian Plateau, the Eurasian Plateaux (also known as the Southeast Asian Plateaus), and the Pacific Plateformes (Tyas & Pujianto, 2020; Verstappen, 2010). This condition makes Indonesia an Indonesian territory that is declared vulnerable to natural disasters such as volcanic eruptions, earthquakes, and tsunamis (Medina, 2015; Widayati, 2020). Based on geographical and geological aspects, Indonesia is one of the most vulnerable to natural disasters

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(Ammelia et al., 2022; Verstappen, 2010). This series of natural disasters has devoured many lives, caused environmental damage, and caused the loss of property (Frasetya et al., 2021; Hidayati, 2012). Indonesia ranks second as the country most affected by tsunamis (Ginting et al., 2023; Hidayati, 2012). The disasters that have occurred in Indonesia have claimed more than 200,000 lives, such as the earthquake and tsunami in Aceh in 2004 (BNPB, 2022; Gadeng et al., 2018). Disasters in coastal areas often result in massive losses of life and property. The main factor in the number of casualties is the lack of human knowledge and preparedness to anticipate and face a tsunami disaster (Mayzarah & Batmomolin, 2021; Seddighi et al., 2020).

Care for disasters is not limited to action at the time or after a disaster occurs but to preventive action and preparation before it occurs. In the context of disaster management, preparedness is a crucial element that determines the level of safety. However, the Indonesian population's preparedness level needs to be higher (Amri et al., 2017; Mailizar et al., 2023). Therefore, efforts are needed to raise awareness and disaster preparedness in society through educational practice.

Alarming statistics and research findings underscore the need for improving disaster preparedness among high school students. According to Sakinah & Zahra (2022), the disaster preparedness index in Indonesia only scores 51 out of 100, placing it in the "less prepared" category. This indicates that a significant portion of the population, particularly adolescents, remains vulnerable to disaster risks. Furthermore, Utami et al. (2021) found that high school students who often live in coastal areas generally perceive the sea only as a habitat for marine life and a source of livelihood for fishermen, overlooking the potential hazards such as tsunamis, storm surges, or sea accidents. This limited perspective contributes to frequent accidents at sea involving adolescents.

High school students, typically aged 12 to 15 years (Chandani, 2020), fall into the early adolescent phase, which is identified as a critical period of vulnerability to disasters. Ningsih et al. (2023) highlight that adolescents are among the most at-risk groups in disaster situations. This vulnerability stems from a need for more knowledge and awareness about disaster risks in their environment, leading to a disaster preparedness deficiency (Sukamto et al., 2021). Adolescents' underdeveloped capacity to anticipate and respond to marine-related threats is exacerbated by the absence of educational interventions integrating local wisdom and contextualized learning about the marine environment.

Given these factors, there is a clear and urgent need for targeted educational approaches to raise awareness and equip high school students with the necessary knowledge and skills to mitigate disaster risks. Developing innovative educational tools, such as interactive games incorporating local cultural values and real-world scenarios, is essential for fostering disaster preparedness in this vulnerable group. This need analysis strongly supports integrating disaster education into the high school curriculum, especially in areas near the sea, to address the critical gap in students' awareness and preparedness.

According to Nada et al. (2022) dan Tyas et al. (2020), disaster preparedness is measured through five key elements: knowledge of disasters, disaster management policies, readiness plans, early warning systems, and resource mobilization capabilities. These five elements must be synergistically integrated to create a society that is resilient to disasters. The level of disaster preparedness is very closely linked to

public awareness in the face of emergencies. One effective method of raising this awareness is by strengthening public knowledge of disasters (Zunariyah et al., 2019).

The incidence of disasters in Indonesia has increased significantly in the last few years. According to the National Disaster Management Agency (BNPB) data, the number of disaster incidents in 2019 reached 3,814; in 2020, it reached 4,650 and increased to 5,402 in 2021 (BNPB, 2022). Indonesia's long experience in the face of disasters is a valuable lesson in improving disaster management.

A good knowledge of disasters can improve preparedness for disasters. Good knowledge will give rise to the desire of the people to be ready in the face of disaster (Narayana et al., 2022; Ningsih et al., 2023). According to disaster data, many disaster victims were school-age children in some districts. It shows the importance of early knowledge of disasters and disaster risk reduction to provide an understanding and guidance of the steps to take when a threat occurs in the vicinity to reduce the risk of disasters (Harada et al., 2023; Sukamto et al., 2021; Tyas et al., 2020).

Education effectively reduces the risk of disasters by providing understanding to educators and learners (Zenis & Abdurrahman, 2021). The school plays a strategic role in disaster management because it provides knowledge (Seddighi et al., 2020; Tyas et al., 2020). This educational institution can improve students' knowledge and skills in the face of disasters. The school's role in disaster management emphasizes cultivating disaster preparedness among students in the school neighbourhood (Lusmianingtyas & Suwarno, 2022; Seddighi et al., 2022).

One attempt to implement disaster risk reduction efforts in the education sector is by integrating them into learning, facilitated by interactive learning media. Marine Eco-Adventure is a marine educational game that embodies board games designed with local values and wisdom, making learning more relevant and understandable (Koopman, 2023; Kusumastuti et al., 2022). Through these games, students can develop critical and analytical skills. Learning activities using game media can encourage students to solve problems (Fadila et al., 2022). Learning media and integrated local wisdom traditions are packaged as board games. Through display, design, and real-life experience through simulation, marine educational games can be an effective tool to teach disaster preparedness to high school students. Applying learning concepts while playing can develop the child's experience in receiving knowledge, influencing learning behaviour, and enhancing their imagination (Pratama et al., 2020).

The objectives of this research include: (1) knowing the concept and development of Marine Eco-Adventure as a marine educational game that can enhance the understanding of high school students about disaster preparedness; (2) knowing about the feasibility of Marine Eco-Adventure as an ocean education game, which can improve the knowledge of high school students on disaster readiness; (3) knowing the effectiveness of using Marine Eco-Adventure to improve preparedness for disaster mitigation.

The development and implementation of Marine Eco-Adventure will be an innovative learning tool, engaging students with practical and cultural knowledge about disaster preparedness. By incorporating local wisdom and interactive learning, the game is expected to inspire a greater sense of responsibility and awareness among students regarding the potential risks in their environment. Additionally, it is anticipated that this game will enhance the students' preparedness for disasters and foster

critical thinking and problem-solving skills essential for effective mitigation. In the long term, Marine Eco-Adventure could be a model for integrating local wisdom into educational curricula, promoting resilience and proactive disaster response behaviours in schools and communities.

METHOD

This research is the research and development of RnD (Research and Development). This research used the ADDIE development model, which is an acronym for analysis, design, development, implementation, and evaluation (see Figure 1) (Dick & Carey, 1996).

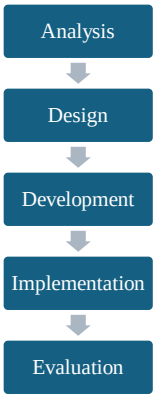

Figure 1 ADDIE Stage

The phase in the ADDIE model, as shown in Figure 1, began with the phase of analysis, which included the analysis of the tradition of Langan as part of the local knowledge of the community. The next stage was design, which involved the reconstruction of local knowledge of the community in the Larungan tradition into scientific knowledge, as well as the development of the design of the media board game Marine Eco-Adventure, including the determination of components, rules, and flow of the game. Further, at the development stage, media board games like Marine Eco-Adventure were developed, validation by the media experts and materials was performed, and revisions were made based on the results of such validation.

The implementation phase was carried out by providing pre-test-related disaster preparedness integrated with the local wisdom of Larungan tradition to identify students' early knowledge. Learning was then carried out using the Marine Eco-Adventure media board game, followed by a post-test after learning and filling a lift to evaluate the student's response to the learning media. At the evaluation stage, data obtained from the pre-test and post-test and the elevation of student response were analyzed, followed by evaluation, reflection, and revision of the final product based on feedback gained during the implementation phase. The population in this study consisted of 8th-grade students in one of the high schools located in the coastal area of Yogyakarta, with a randomly selected sample. The school was located in the coastal area of Parangtritis Coast and has disaster emergency status.

The research used a qualitative approach with the design of one group pre-test and post-test. Data collection used interview techniques, needs analysis, student response to media, and dual choice issues (pre-test and post-test) to measure student understanding of disaster preparedness. The data analysis technique used in developing board games Marine Eco-Adventure used qualitative and quantitative data analysis techniques.

The data analysis in this study was conducted through both qualitative and quantitative approaches. The qualitative data was derived from interviews regarding the Natural Science Society’s perspectives on the Larungan tradition and analyzed using qualitative descriptive techniques. On the quantitative side, several analyses were employed. The learning media needs were assessed through a requirements analysis using quantitative descriptive

methods. The validation of the learning media, Marine Eco-Adventure, was evaluated with Aiken's V coefficient to measure its validity. To assess the effectiveness of the media in improving disaster preparedness, pre-test and post-test results were analyzed using descriptive statistical analysis (N-Gain), followed by inferential statistical analysis (T-Test) through SPSS 26. Additionally, user responses to the media were collected and analyzed using quantitative descriptive techniques.The data collection techniques are presented in more detail in Table 1.

Table 1 Data collection techniques

No.	Data type	Data Collection Tool	Data Analysis Techniques
1.	Learning Media Needs	Requirements Analysis Lift	Quantitative Descriptive
2.	Natural Science Society on the Larungan Tradition	Interview Guidelines	Qualitative Descriptive
3.	Learning Media Qualification	Validation Assessment Sheet	V Aiken's
4.	Increased Disaster Preparedness	Pre-Test and Post-Test	a. Descriptive statistical analysis (N-Gain) b. Inferential statistical analysis (T-test) using SPSS 26.
5.	User Response	Lift Response	Quantitative Descriptive

The Ethics Commission of the Directorate of Research and Commitment to the Society of Yogyakarta State University, number T/41/UN34.9/KP.06.07/2024, approved research.

RESULT AND DISCUSSION

The process of creating the Marine Eco-Adventure board game uses R&D (Research and Development) with the ADDIE development model developed by Dick and Carry (1996). Developing the Marine Eco-Adventure board game begins with conducting a needs analysis. Larungan is a traditional ceremony that is still preserved in various coastal areas of Indonesia. According to Sidiq (2022), this tradition involves casting offerings into the sea as a form of gratitude and a plea for safety. The Larungan reflects local wisdom and the harmonious relationship between coastal communities and their environment.

This tradition is an educational tool for the community, especially for junior high school students, in enhancing disaster preparedness. This tradition can be reinterpreted through a scientific approach, so it serves as a spiritual ritual and a tool to raise public awareness of the potential for natural disasters, such as tsunamis. Disaster preparedness can be strengthened by preserving the environmental ecosystem through traditions, including Larungan. The Larungan tradition teaches the importance of loving, caring for, protecting, and preserving the environment, contributing to disaster mitigation efforts (Zuliyanti, 2023).

The data collection and analysis of needs and the information obtained will then be processed to create content and serve as a foundation for developing the game Marine Eco-Adventure. This is done by analyzing the original science of the community in the Larungan tradition, which is then reconstructed into scientific science. The matrix of materials was compiled to obtain the correlation between the Larungan tradition and science, particularly regarding disaster preparedness, based on the results of interviews.

Through the Larungan tradition, junior high school students can be introduced to scientific phenomena such as tidal movements, wind, and ocean currents related to the ritual's timing. In addition, Larungan can be implemented to simulate disaster evacuations. This is in line with Zuliyanti's (2023) research, which involves students in evacuation drills using disaster scenarios such as tsunamis, allowing them to gain knowledge about safe evacuation routes and the actions that should be taken during a disaster.

The design of this Marine Eco-Adventure is packaged in the form of a board game to learn about disaster preparedness through the tradition of larungan. This board game requires students to complete a path that contains prohibitions, actions, or questions that can be answered and resolved by the students while playing the game.

This game was developed without using electronic devices; all the components used are already available, so students just need to assemble and play it. After going through the game design phase, validation by subject matter experts and media experts was conducted. Tables 2 and 3 show the results of Aiken's V values from the assessments of content and media experts.

Table 2 Results of V Aiken's expert material validation analysis

Item	Valuer		S1	S2	Σs	n	V	Information
	I	II						
1-19	92	93	73	74	147	152	0.97	Very High

Table 3 Results of V Aiken's expert media validation analysis

Item	Valuer		S1	S2	Σs	n	V	Information
	I	II						
1-20	91	86	71	66	137	160	0.85	Very High

Table 2 shows that Aiken's V value from the content expert is 0.97, and from the media expert is 0.85, both categorized as "Very High." This indicates that almost all aspects of the content and media evaluated by the content and media experts are considered relevant, aligned with the learning objectives to be achieved, and are very suitable to support the learning process. This is in line with Sugiyono's (2021) opinion that high instrument validity indicates that the instrument can measure what it is supposed to measure very well.

Although the validation results indicate a "Very High" category, the validators still provided suggestions and feedback for improvement. This is in line with Rosyidi and Daryanto's (2023) opinion that input from experts is very important for improving the quality of the developed products. After considering the feedback, improvements were made that resulted in game board components that matched those illustrated in Figure 2.

Implementing the board game media Marine Eco-Adventure in learning is an innovation to enhance students' disaster preparedness. This study applied the learning media to 32 8th-grade students at SMP Negeri 2 Kretek, as shown in Figure 3. The implementation process includes administering pre-tests and post-tests to measure the effectiveness of using learning media to improve students' knowledge and preparedness for disasters.

(a) (b)

Figure 1 (a) Marine eco-adventure's board game and (b) Students playing the marine eco-adventure board game

The pre-test stage is given to students before implementing the product to measure their level of disaster preparedness. This pre-test is intended to assess students' knowledge and readiness before using the Marine Eco-Adventure board game. A pre-test is essential in educational experimental research as it provides an initial overview of the student's abilities or knowledge before the intervention is conducted (Hamid & Nurhasanah, 2022). Process learning using the board game Marine Eco-Adventure is conducted after the pre-test. The use of board games in education has proven effective in enhancing student engagement and motivation and facilitating more contextual knowledge transfer (Ramadhani & Setiawan, 2021). Moreover, the use of interactive learning media, such as educational games, has been widely recognized for its ability to simplify complex concepts and create a more immersive and enjoyable learning experience, making it an invaluable tool in fostering deeper understanding and long-term retention of knowledge (Agusty et al., 2021; Wahyuningtyas et al., 2021).

At the end of the lesson, students were given a post-test to measure the level of disaster preparedness they had achieved after using the Marine Eco-Adventure board game media. The comparison of pre-test and post-test results allows for measuring the extent of knowledge and preparedness improvement among students after participating in the lesson. The increased post-test results indicate that the Marine Eco-Adventure board game media effectively enhances students' disaster preparedness. This is in line with research by Suhendar (2023) that using interactive and game-based learning media can significantly improve student learning outcomes in disaster education. Furthermore, these engaging tools provide a more immersive learning experience, enhancing students' retention of critical disaster preparedness information and fostering a deeper understanding of real-life disaster scenarios. The results of improving student understanding are shown in Figure 3.

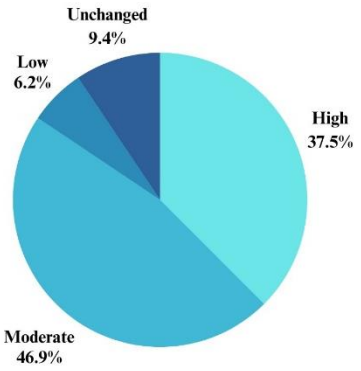

Figure 3 Graph of student understanding improvement

Based on the analysis results shown in Figure 3, it is known that 37.5% of students fall into the "high" category of understanding. 46.9% of students are in the "Medium" category. Meanwhile, 6.2% of students are in the "Low" category, and 9.4% did not experience any change in understanding. More than 50% of students showed an improvement, which aligns with most students living in coastal areas. This is in line with Adiyoso & Kanegae (2013; Winarni et al. (2021) research that respondents' good knowledge is a result of the abundance of news and information about earthquake disaster events occurring in their surroundings. Table 4 shows the results of the descriptive statistical analysis.

Table 4 Results of descriptive statistical analysis

	N	Mean	Std. Deviation	Min	Max
N-Gain	32	0.5627	0.26568	0.00	1.00

Table 4 shos that the average N-Gain of 0.5627 indicates an improvement in readiness in the "Moderate" category. This category indicates that using the Marine Eco-Adventure board game effectively enhances students' preparedness. This increase indicates that students have experienced a significant improvement in understanding and preparedness after participating in the learning process, although they have not yet reached the "High" category. This aligns with the research by Siregar & Tambunan (2022) and Wahyuningtyas et al. (2021) that interactive learning media often results in improvements in the "Medium" category when used over a relatively short period or with students who have a heterogeneous level of prior knowledge. Table 5 shows the data from the normality test analysis.

Table 5 Results of the one-sample kolmogorov-smirnov test analysis

		N-Gain
N		32
Normal Parameters[a,b]	**Mean**	.5627
	Std. Deviation	.26568
Most Extreme Differences	**Absolute**	.100
	Positive	.077
	Negative	-.100
Test Statistic		.100
Asymp. Sig. (2-tailed)		.200[c,d]

Test for normality using the One-Sample Kolmogorov-Smirnov Test. Table 5 shows that the asymptotic significance value (2-tailed) of 0.200 > 0.05 indicates that the N-Gain data for disaster preparedness is normally distributed. The normal distribution of this N-Gain data for disaster preparedness is important because it ensures that the normality assumption is met, allowing for the accurate execution of advanced statistical analyses such as the t-test. As explained by Purwanto and Lestari (2023), data normality is one of the fundamental assumptions that must be met before conducting parametric statistical analysis, as deviations from normality can affect the results of statistical tests and data interpretation. The results of the one-sample t-test analysis are shown in Table 6.

Table 6 Results of one-sample t-test analysis

t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
				Lower	Upper
11.98	31	0.000	0.56272	0.4669	0.6585

The effectiveness of implementing the Marine Eco-Adventure board game media was tested using a One-Sample T-Test. Table 6 shows a Sig. (2-tailed) value of 0.000 < 0.05, indicating that using the Marine Eco-Adventure board game media effectively enhances preparedness for disaster mitigation. According to Setyawarno (2016), a Sig. A value smaller than 0.05 in a t-test indicates a statistically significant difference between the tested average and the comparison value. This result confirms that the board game Marine Eco-Adventure positively impacts students' preparedness. This is in line with the research by (Rahayu & Permatasari, 2022; Winarni et al., 2021), which found that game-based learning media not only enhances student engagement in the learning process but also strengthens their understanding through a more interactive and enjoyable approach.

The distribution of the student response questionnaire regarding the Marine Eco-Adventure learning medium was conducted after the implementation. The survey relates to ease of use, visual design, content material, and the media's usefulness. In addition, four student representatives were also asked to provide testimonials after using the Marine Eco-Adventure learning media. Overall, 81.25% of students stated that the Marine Eco-Adventure can enhance their motivation to learn about disaster preparedness and improve their understanding of concepts related to disaster readiness. This high percentage indicates that the majority of students feel that this medium is not only engaging and easy to use but also effective in helping them understand the material being taught. According to Widiastuti and Prasetyo (2021), learning motivation is a key factor in the success of the learning process, and learning media that can enhance motivation will positively impact students' learning outcomes.

Ease of use and visual design are also important aspects that influence student learning. Learning media with an attractive design can make the learning process more enjoyable. This is in line with the findings by Saputra and Hermawan (2023), which show that well-designed learning media can enhance students' interest and motivation to learn. When students engage with visually appealing and user-friendly media, their learning experience becomes more immersive and less intimidating, especially for complex subjects like disaster preparedness. A well-thought-out design helps in simplifying abstract concepts, making them more accessible and relatable to students. Furthermore, interactive elements combined with an intuitive interface can stimulate curiosity and sustain student attention, ultimately improving the material's retention and comprehension. Therefore, prioritizing aesthetics and functionality in educational media development is essential for maximizing its effectiveness in the classroom.

The usefulness of media in helping students understand the concept of disaster preparedness is a key point in the results of this survey. A better understanding of the concept after using the Marine Eco-Adventure board game media shows that this media is a learning aid and a means to reinforce students' knowledge and awareness of the importance of disaster preparedness. This is supported by research conducted by

Nugroho and Lestari (2022) that shows that effective learning media can significantly enhance students' conceptual understanding. Overall, the results of the questionnaire and student testimonials provide evidence that the Marine Eco-Adventure board game is an effective learning medium for enhancing students' understanding of disaster preparedness.

CONCLUSION

Based on the research results, it can be concluded that (1) the concept and development of this game involve various strong elements and are designed to enhance junior high school student's understanding of disaster preparedness in marine environments. (2) The feasibility of the Marine Eco-Adventure game is reinforced by validation results from the subject matter and media experts, categorized as "very high." (3) This research shows that Marine Eco-Adventure is an effective learning medium for improving junior high school student's understanding of disaster preparedness. This game has been tested and proven to deliver content in an engaging and easily understandable way for middle school students.

The findings of this study suggest that integrating local wisdom into educational media significantly improves students' awareness and readiness for disasters. The success of Marine Eco-Adventure presents an opportunity to develop similar interactive learning tools that address other types of environmental or community-based risks. Further development could include expanding the game to different geographical regions, incorporating more advanced scenarios, or adapting the game for use in higher education or community training programs, broadening its impact on disaster preparedness education.

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